Environmental Pollution and Child Health in Central and Eastern Europe

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For the last 50 years, the economic and industrial development of the nations of Central and Eastern Europe has been achieved at the cost of environmental degradation. The health risks posed by this pollution to children and the steps necessary to ameliorate such risks are only beginning to be investigated. At a recent conference in Poland, sponsored in part by the National Institute of Environmental Health Sciences, participants from 11 countries in the region, together with scientists from Western Europe and the United States, met to share information regarding pediatric environmental health in Central and Eastern Europe, to consider methodologic issues in the design and conduct of such studies, and to discuss preventive strategies. This report summarizes the deliberations, outlines problem areas such as heavy metals and air pollution, delineates research and training needs to help Central and Eastern Europeans deal more effectively with such problems, and recommends specific future actions and collaborative efforts. *Key words*: air pollution, Central Europe, child health, Eastern Europe, environmental pollution, heavy metals. *Environ Health Perspect* 106:307–311 (1998). [Online 5 May 1998]
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The nations of Central and Eastern Europe have emerged from a political system that emphasized rapid industrialization at the cost of environmental degradation. The health risks posed by this pollution are only recently being investigated. The purpose of this paper is to summarize the conclusions and recommendations of a recent conference in Sosnowiec, Poland, that examined the health effects of environmental pollutants on children in Eastern and Central Europe.

Background

Vulnerability of children to environmental pollutants. While our knowledge is incomplete, some important differences between children and adults in exposure pathways are well documented (*1*). For example, infants and young children have much greater surface-area-to-volume ratios than adults, thereby increasing the potential exposure through the skin. Infants and young children engage in oral exploratory behavior and often play on the ground, thereby increasing potential ingestion of contaminants in soil and dust. Exposure through respiration may be increased because infants and children inspire air closer to the ground than adults do, increasing the potential intake of contaminants from the soil and dust. In addition, children are more exposed to dietary sources of pollution. Because of their rate of growth, they need more nutrients and consume more food per unit body weight than adults. Any xenobiotics in the diet will be consumed at a proportionately greater rate.

Absorption, metabolism, and excretion also vary from the perinatal period to adulthood. For example, in the gastrointestinal tract, gastric pH changes markedly in the months after birth, and pH will affect absorption of chemicals from the stomach (*2,3*). Metabolic differences between children and adults are related to the maturation of enzyme systems for pathways involved in biotransformation of chemicals (*4*). Excretion also varies with maturation of the kidney and other systems. For example, glomerular filtration does not reach adult levels until about 1 year of age, while tubule length and glomerular diameter increase until adulthood (*5*).

Susceptibility of the target organ may vary with maturation. Exposure to xenobiotics during the fetal period, especially during organogenesis, produces more severe effects than exposure during adulthood; for example, the fetus is far more sensitive to methylmercury than is its mother (*6*). Sensitivity to environmental pollutants may not be confined to the prenatal period because some organ systems continue to develop postnatally. In the human, neurons are added postnatally (*7*), and myelination of many tracts is not complete until long after birth (*8*).

Pediatric environmental health. Despite the biological differences between children and adults, pediatric environmental health has received relatively little attention. For example, the risk assessment and risk management processes that underlie environmental regulations and policy did not until recently take into account the different and complex vulnerabilities of a developing child, and have often focused instead on adult exposure and on the toxicant and hazard (*9*). With the recognition of the special vulnerability of children, earlier studies of children's responses to toxicant exposures have new significance. Knowledge of children's developmental sensitivity to environmental hazards in general dates from investigations of child health and labor practices conducted more than a hundred years ago (*10*) and is consistent with the more recent use of child development and growth patterns as an indicator of environmental health (*11,12*).

Although there is growing evidence linking child health to lead (*13*), polychlorinated biphenyls (*14*), and air pollution (*15*), the effects of many other environmental pollutants on children remain unknown (*16*). This gap reflects, in part, methodologic problems such as the accuracy of the exposure assessment, the possibility of selection and recall biases, the lack of appropriate comparison groups, and the failure to control adequately for confounding variables. Current and future research needs to address these problems more thoroughly so that critical gaps in current knowledge can be filled and information needed to help protect children from the health risks of environmental pollution obtained.

Environmental pollution in Eastern and Central Europe. Environmental pollution and degradation are serious problems in Eastern and Central Europe (*17*), resulting from the fact that little attention was devoted to the consequences of rapid industrialization during the communist years. The problem is endemic across the region, but the types and sources of contaminants vary by nation. For instance, in Bulgaria and the Slovak Republic, heavy metal industries have produced wastes that are deposited into landfills without special precautions (*18,19*). In Romania, approximately half of the population lives in the

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vicinity of waste sites that do not conform to contemporary standards (*20*). In the Czech Republic, coal and uranium mines have produced serious pollution problems, and much of the solid industrial waste containing heavy metals is disposed of, without pretreatment, in open dumps (*21*). The worst pollution in Hungary comes from open cast mines, lignite-based power plants, chemical factories, and the aluminum industry (*22*). The Silesia district in the south of Poland has severe air, water, and soil contamination from mining and industry (*23*). Chernobyl is of chief concern in the Ukraine, but air pollution and soil and water contamination are also critical issues in that nation (*24*).

Progress in pediatric environmental health in Eastern and Central Europe. Despite the magnitude of the environmental pollution in Central and Eastern Europe, research on its impact on human health in general and on children specifically has only recently been initiated. In the Czech Republic, for instance, neonatal mortality has been positively related to total suspended particulates (*25*). Dziegielewska et al. (*26*) have found reduced levels of the plasma protein α1-antitrypsin among children living in heavily polluted areas of Poland; this deficit may compound the impairment of lung function in these children. In Romania, lead exposure has been linked to nephrotoxic effects in children living near a smelter (*27*).

Obstacles to pediatric environmental health research in the region are numerous, including lack of financial resources, inadequate and often unreliable data, shortage of sophisticated computer and laboratory equipment, gaps in basic and applied knowledge, and persistent distrust between the public and governmental agencies (*28*). Some nations are beginning to initiate programs to help address these problems. For instance, the Hungarian National Institute of Hygiene has developed the Children's Acute Respiratory Morbidity Surveillance System (CHARM) to monitor and research air pollution and its association with respiratory diseases (*29*). International efforts are also underway, many of which are coordinated by the World Health Organization (WHO). The WHO European Centre for Environment and Health in Bilthoven, Netherlands, for example, has introduced the National Integrated Programmes on Environment and Health (*30*). The principal goal is to convert information gathered by cooperating institutions in the region into understandable data for policy and decision making and for the interested scientific community. There nevertheless remain significant gaps in understanding the health risks posed by environmental pollution to the children of Eastern and Central Europe and what should be done to ameliorate such risks.

Summary of the Conference

To help address these gaps, a conference on Environmental Pollution and Child Health: Critical Issues for Central and Eastern Europe was held in Sosnowiec, Poland, 8–10 May 1996. The sponsors were the School of Public Health, University at Albany, State University of New York; the Institute of Occupational Medicine and Environmental Health, Sosnowiec, Poland; the National Institute of Environmental Health Sciences (NIEHS); the WHO - European Centres for Environment and Health; and the Fogarty International Center, National Institutes of Health. The purposes of the meeting were to exchange state-of-the-art scientific data regarding the health risks posed to children from environmental pollution and to discuss methodologic issues encountered in the design and conduct of such studies. The specific goals were 1) to provide scientists, physicians, and other health professions from Central and Eastern Europe with information to help them address their pediatric environmental health problems; 2) to help standardize methods among scientists from different nations; and 3) to foster collaborative research and training among Eastern and Central Europe and with Western Europe and North America. More than 100 persons from 11 countries in Eastern and Central Europe attended; 13 Western Europeans and 12 Americans also participated.

The attendees consisted primarily of physicians and researchers in epidemiology, public health, and the environmental sciences. Six symposia, consisting of three presentations each, served as the core of the meeting. Each dealt with a central theme of particular concern to Central and Eastern Europe: 1) lead exposure assessment, 2) lead health effects, 3) air pollution, 4) congenital malformations, 5) registries, and 6) methodologic issues in reproductive studies. The conference also featured 10 moderated roundtables where the themes of the symposia, together with other topics such as ionizing radiation, organic compounds, and prenatal growth and development, were discussed informally and in greater depth. In addition, 30 posters were presented in a special session to provide students and new investigators with a forum. The proceedings were published in the June 1997 issue of the *Central European Journal of Public Health* (Vol 5, No 2). The meeting follows a 1994 conference in Prague sponsored by the University at Albany, the NIEHS, and the Czech National Institute of Public Health (*31*). That conference focused on the identification of environmental problems in the region, especially hazardous waste issues, while this meeting emphasized the health risks of such pollution, particularly among children.

Problem Areas and Research and Training Needs

Heavy metals. Of the heavy metals, lead and cadmium are of greatest concern. The main sources appear to be industrial ones, especially lead smelters. Czech participants presented results suggesting that blood lead levels may have declined in some areas of their nation over the past decade, but earlier data may not provide an accurate baseline for comparison (*32*). In Hungary, blood lead levels are associated with motor vehicle traffic, reflecting the impact of leaded gasoline (*33*). In Poland, the consumption of locally grown vegetables is positively correlated with child blood lead levels in Upper Silesia as a result of soil contamination (*34*). Elevated levels of lead, nickel, chromium, and manganese in hair were reported for children from urban Riga compared with children from less industrialized areas of Latvia.

A major problem is determining the extent of elevated levels of lead and other metals in the pediatric population of this region. Population surveys are expensive and, if they became part of the usual public health expenditure, could consume a substantial percentage of the overall public health budget of nations with severely limited financial resources. On the other hand, it is not clear how to identify children with elevated lead levels without population-based screening. If screening programs are to be developed to target specific groups of children at risk, a critical screening level must be established. Despite considerable knowledge of effects of lead above 10 μg/dl, uncertainty remains concerning detrimental effects of levels below that threshold.

An attractive alternative to screening is the use of exposure models (*35*). There is a definite need to develop better exposure models through comparisons of model predictions with either survey-based bioassay data or direct environmental sampling. Better methods of environmental sampling, particularly dust sampling, would be necessary to achieve this goal. More standardization of protocols across investigations would also be required.

More knowledge is necessary on the role that vitamins and minerals in the diet could play in the absorption, distribution, and excretion of heavy metals. In particular, the effect of high dietary intakes of calcium

and vitamin D on lead absorption in children needs to be understood more fully. Supplementing dietary calcium is used by some physicians in the region to treat lead-exposed children, but its effectiveness has not been adequately tested.

The impact of lead on the central nervous system was discussed, particularly in terms of cognitive and behavioral development and school accomplishment (*36*). For instance, Croatian researchers reported that low-level lead exposure was associated with reduced reaction time and subtle deficits in various intelligence scales. In Poland, blood lead was found to be related to electroencephalographic abnormalities, even in the absence of classical pathological findings such as chronic neuropathy or neuronal injury. Though these effects could be small in individuals, when the size of the population that is exposed is considered, the effect on society could be substantial. It was agreed that to further our understanding of the effects of low levels of lead, there should be a balance of two types of investigations: those of behavioral signatures (i.e., specific behavioral outcome tests that may be affected only or preferentially by lead) and summary outcomes (e.g., physical growth, morbidity, mortality). Summary outcomes were thought to be important because of the variety of materials to which pediatric populations in the region are exposed. Most environmental exposures in Eastern and Central European countries are to combinations of many metals, yet little is known about interactions that could worsen or lessen the effects of any metal alone.

Air pollution. Ambient air pollution is a major problem in the eastern European region, given the heavy reliance on coal-burning power plants. Current monitoring focuses heavily on total suspended particulates and relatively insensitive block monitoring. More sensitive techniques including the measurement of particulate matter ≤10 μm (PM_{10}) and $PM_{2.5}$ (≤2.5 μm) need to be implemented and validated. Further research is needed to delineate the relationship between particulate matter and adverse respiratory effects, an association which appears to be less pronounced regionally than that observed in Western Europe and North America. Standardization of health end points such as asthma is also necessary. Some Eastern and Central European scientists have studied the prenatal impact of environmental tobacco smoke on pregnancy outcomes such as birth weight; however, collaboration with Western scientists who study postnatal effects would prove useful (*37*). The importance of such research is underscored by the greater prevalence of cigarette smoking in Eastern and Central Europe compared to that in the United States.

Relatively little research has been conducted on the effects of indoor air pollutants other than environmental tobacco smoke. Assessing the impact of exposure to other indoor agents such as solvents, bioaerosols, and combustion by-products would be useful. To delineate and evaluate the complex influences of different environmental, social, and economic factors on the risk of respiratory disorders in children, techniques such as Geographic Information System (GIS) technology and spatial statistics should be more widely employed throughout the region (*38*).

Ionizing radiation. At present, concern about contamination from the Chernobyl disaster overshadows consideration about other sources of ionizing radiation. Conference participants presented data indicating higher rates of thyroid cancer and dysplasia, digestive diseases, respiratory disorders, vascular dystonia, immune disorders, and blood and nervous system diseases among Chernobyl children, especially those born within 2 years of the accident, relative to other Ukrainian children. It is difficult, however, to evaluate accurately the extent of damage from radiation released by the Chernobyl nuclear power plant. One problem is the lack of predisaster health data to provide valid baseline levels by which to judge effects of radiation from Chernobyl. Current studies of direct biological effects of radiation are handicapped by the co-occurrence of psychological, social, and economic impacts of the disaster in the affected communities.

Other sources of ionizing radiation in Eastern and Central Europe were also recognized. There is a history of uranium mining in the region, and disposal and storage of tailings are not well controlled, providing opportunities for exposure to children. Coexposures to radiation and heavy metals and the possiblity of interaction effects is another problem. A collaborative team of scientists is needed to separate direct effects of exposure to radiation from health impacts related to the stress of relocation and of the sense of self-contamination.

Persistent organics. Compared to heavy metals and suspended particulates, relatively little research has been devoted to the impact of organic compounds on pediatric health in the region. The potential nevertheless exists for adverse health effects from these chemicals, given pesticide and herbicide contamination from agricultural practices, polycyclic aromatic hydrocarbons emitted into the air from steel factories, and the presence of phenols and other chlorinated compounds in drinking water. In the United States, Western Europe, and Japan, polychlorinated biphenyls, dibenzofurans, and dioxins are major concerns, but in Eastern and Central Europe, their presence and potential effects have been virtually ignored. Biological monitoring to help establish levels of persistent organics in human tissue would be useful. Markers of early biologic effect, for example, measuring P450 liver enzyme activity with the caffeine breath test (*39*) would also help identify affected populations before the onset of clinical disease.

Congenital malformations and registries. Two primary concerns in the area of birth defects were identified by the participants: 1) the limitation of knowledge of baseline rates and 2) the difficulty in comparing circumstances in Eastern and Central Europe to other European or American registries. Physicians from Poland, the Ukraine, and Lithuania, for instance, reported on variation in birth defect rates and in fertility that could be associated with environmental contamination; but determining the importance of environmental factors is difficult, given uncertainties about ascertainment and other risk factors. Hungary is one of the few countries in the region with an established birth defect registry, and that registry reported success in evaluating possible environmental causes of perceived clusters of birth defects (*40*).

Despite the usefulness of registries, investigators from countries currently operating birth defect registries did not uniformly endorse the establishment of potentially costly registries. Instead, they emphasized the importance of complete and valid vital records systems as a baseline. When registries are recommended, they should be built upon the health care delivery and public health system present in Eastern and Central European countries. International health agencies and registry consortia could provide guidance and standard procedures to assist in the development and operation of new or improved registries.

Fetal growth and development. Child growth and development has been well studied in Eastern and Central Europe for many years, resulting in large databases of pediatric anthropometry that describe growth patterns. More recent studies linking fetal development to environmental exposures build upon this foundation of interest and expertise. For example, Ukrainian investigators reported an association between decreases in child growth and development in recent years and agricultural pollution and contaminated drinking water. Because of the sensitivity of physical growth to a wide spectrum of environmental factors, the interpretation of growth data in terms of environmental pollutants requires additional

data on familial, social, and biological factors. The need for a basic standard questionnaire for collecting such data was recognized, and interest and support for development of such as questionnaire was requested.

In addition, the protocols of growth measurement, especially neonatal measurement, need further standardization. Because head circumference and especially birth length are so often measured inaccurately, their usefulness is probably underrealized. Training in anthropometry and gestational age assessment is needed. The use of devices such as the Guthrie card for collecting blood droplets from newborns should be considered for later use in bioassays.

Preventive strategies. Preventive strategies, using education, research, and advocacy, are lacking in the region. Such strategies should be initiated and should employ comparative risk and cost/benefit analysis. They should also take an integrated approach, including the involvement of industry and agriculture. Further research that focuses on nutrition as a preventive strategy is a potentially fruitful area. Collaboration with nongovernmental groups dedicated to the prevention of childhood exposures to environmental hazards such as the Children's Environmental Health Network in Emeryville, California, would help facilitate the process through the sharing of existing educational materials targeted at school-aged children, parents, physicians, and the media and through training sessions and workshops for physicians, researchers, and policy makers. Such programs, however, must be coordinated with governmental agencies such as Ministries of Health to be effective. Given the limited financial resources of countries in the region, primary prevention would be more cost-effective than secondary measures (i.e., screening) and tertiary measures (i.e., treatment of affected children).

Conclusions and Recommendations

Although the situation varies by country, the consensus of the conference was that the greatest immediate threats to the health of children in Central and Eastern Europe are heavy metals and air pollution. The extent of the pollution and the actual health risks it poses to children, however, are unknown. To address these questions, new action is required, ranging from proper training of environmental health professionals to research and public education, legislation, and a problem-oriented infrastructure. Networks should be established among Central and Eastern European scientists and their counterparts in the West to share state-of-the-art information regarding methods and health effects. Such networks would provide access to existing protocols and help harmonize efforts. There is also a great need to make more readily available in Central and Eastern Europe current scientific literature and computer hardware and software. Training in epidemiology and laboratory sciences such as environmental chemistry is another necessity. This training would be most cost-effective if offered short term and in-country, and must be coordinated with ongoing efforts by the WHO.

New and innovative research strategies such as biomarkers of exposure and early effect are currently unavailable to most pediatric environmental health scientists in Central and Eastern Europe. Given the limited financial resources available to most countries in the region, however, these approaches should not be implemented at the expense of more traditional methods. For example, although birth defect registries are helpful for surveillance and to identify clusters, they are costly and difficult to maintain. It may be more cost-effective to improve the quality of birth certificates and other more routine sources of data. Other obstacles include inflexible organizations and lack of coordination between scientists and governmental officials. Surmounting this problem will entail effecting governmental change and better integrating science and policy. Plans should also be developed to more effectively communicate risk to both physicians and the public and to educate them in both primary and secondary prevention.

Future meetings should be small and targeted on specific pediatric environmental health concerns such as birth defects or the effect of complex chemical mixtures, with focused discussion on problem solving.

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